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RESISTOR STRUCTURES TO ELECTRICALLY MEASURE UNIDIRECTIONAL MISALIGNMENT OF STITCHED MASKS

1. The present invention relates to matched resistors structures. More particularly, the present invention relates to the measurement of unidirectional misalignment of stitched masks for etched interconnect layers.

2. In prior art, the techniques to measure stitching offsets normally use an optical means to detect variations in stitching. For example, U.S. Patent 4,431,923 to Wang et al. discloses a process for accurately aligning a chosen member with a focused beam of radiation or for aligning two chosen members with each other. A set of alignment marks having a predetermined spatial pattern is first provided on the surface of each member. Next, a detection signal is generated from the set of alignment marks, comprising a serial electronic signal as a function of time and containing serial information corresponding to the relative position of each mark in the set of alignment marks. Then, the detection signal is electronically processed to generate an alignment signal with a high signal-to-noise ratio. Next, the alignment signal is compared to a reference signal signifying a predetermined criterion of alignment, to generate an error signal which is indicative of the extent of misalignment. Finally, lateral movement of one chosen member is produced in response to the error signal until accurate alignment of the chosen member with the focused beam of radiation or of the two chosen members with each other is achieved.

It is also known in the art that the resistance of an IC interconnect is measured in squares, and that narrower segments are more resistive for a given length. It is also known that stitching can cause uncertainties due to mask alignments.

The present invention is directed to a method and apparatus for isolating offset detection of etched resistors of a stitched mask set by using mask misalignment for the variable resistor. For example, when a first mask of a first structure and a second mask of a second structure are aligned, the structures have the same resistance value as there is no offset on the secondary mask of a stitched mask set. However, when an offset

occurs, one structure's resistance will decrease by the same value as the other structure's resistance increases.

Figs. 1A and 1B illustrate respective resistive components of a stitched mask set prior to being joined together.

Fig. 1C illustrates a superimposed view of Figs. 1A and 1B so that the two components are joined together and are in alignment.

Fig. 1D illustrates the stitched mask set having components that are misaligned in first direction relative to a vertical offset.

Fig. 1E illustrates the stitched mask set having components that are misaligned in a second direction relative to a vertical offset.

Figs. 1F and 1G illustrate another embodiment of the present invention, wherein the components overlap.

Fig. 1H shows the components of Figs. 1F and 1G superimposed, wherein the two components are joined together and in alignment.

Fig. 1I shows a stitched mask set having components that are misaligned in a first direction relative to a vertical offset.

Fig. 1J shows a stitched mask set having components that are misaligned in a second direction relative to a vertical offset.

In the following description, for purposes of explanation rather than limitation, specific details are set forth such as the particular architecture, interfaces, techniques, etc., in order to provide a thorough understanding of the present invention. However, it will be apparent to those skilled in the art that the present invention may be practiced in other embodiments, which depart from these specific details. Moreover, for the purpose of clarity, detailed descriptions of well-known devices, circuits, and methods are omitted so as not to obscure the description of the present invention with unnecessary detail.

Fig. 1A shows a first test pad 101 and a second test pad 102 that are used for aligning the etched resistor structures 105, 110 (shown in Fig. 1B) according to a first aspect of the present invention. The desired effect is to superimpose Figs. 1A and 1B so as to make one resistor structure that is electrically connected by vertical offset 112.

The geometry of the structure isolates the offset direction and may cause the resistance between the test pads to decrease proportionally or increase proportionally. For example, as shown in Fig. 1D, the resistance between the test pads will decrease

proportionally to the vertical offset 112. Similarly, if the misalignment occurs as in Fig. 1E, the vertical offset 112 between the resistor structures is longer and the resistance between the test pads will increase proportionally.

With regard to Figs. 1F through 1J, it can be seen that the resistive elements 115, 125 are designed so that there is some degree of overlap of the paths when the elements are joined together.

Figs. 1F and 1G can have their masks superimposed so as to create the condition shown in Fig. 1H, wherein the resistance at the test pads is at a lowest level. If the mask 125 is misaligned as shown in 1I, the resistance between the pads will increase proportionally to the vertical offset. Conversely, if the mask 125 is misaligned as shown in Fig. 1J, the resistance between the test pads will decrease proportionately.

A method for testing the aligning the etched stitch masks would be to first connect a first stitched resistor 105 to a first test pad 101. A second stitched resistor 110 having a vertical offset connection 112 would be connected to an end of the first stitched resistor, preferably so that the first and second stitched resistors are vertically aligned relative to the offset. At this step the resistance would either be measured or displayed. In the case that the resistor structures are in alignment, there would be a predetermined resistance amount from which it would be ascertained that the placement is correct. A indicator signal 103, such as a green light, would indicate that no further alignment is required.

If there is a misalignment, a color indication, such as a red light, could turn on to signify a misalignment. It should be understood that the signals do not have to be colors, they could be sounds or values displayed on the test pad (in ohms, for example) could be substituted. Also voice instructions, in addition to the visual cues, or in place thereof, could easily be used in place thereof or in addition thereto.

The structure geometries isolate the offset direction. In addition, the structures are chosen such that at ideal alignment (zero offset) the resistance of structures shown in Figs. 1C and 1H will be equal, due to having the same number of turns, the same length of wide interconnect and the same length of the narrow interconnect. Also, one could actually receive a desired resistance between two joined structures of unequal resistance by intentional misaligning. Thus, an accurate measurement can be made without introducing expensive optical systems into use. Once the resistance measurements are determined to be within a predetermined range, the masks can then be used, or

alternatively, if they are outside the predetermined range, the item could be flagged as defective.

While the preferred embodiments of the present invention have been illustrated and described, it will be understood by those skilled in the art that various changes and modifications may be made, and equivalents may be substituted for elements thereof without departing from the true scope of the present invention. In addition, many modifications may be made to adapt to a particular situation and the teaching of the present invention without departing from the central scope. Therefore, it is intended that the present invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out the present invention, but that the present invention includes all embodiments falling within the scope of the appended claims.